AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Evaluation Summary
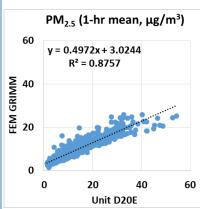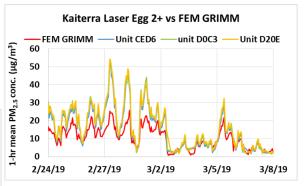
- Overall, the Kaiterra Laser Egg 2+ sensors showed fairly constant accuracy (47% to 65%) over the $PM_{2.5}$ conc. range tested and overestimated $PM_{2.5}$ mass conc. from FEM GRIMM in the laboratory experiments at 20 °C and 40% RH.
- The Laser Egg 2+ sensors exhibited high precision for all T/RH combinations and all PM concentrations.
- The Laser Egg 2+ sensors (IDs: CED6, D0C3 and D20E) showed low intra-model variability.
- Data recovery was ~ 76% and 97% from all units in the field and in the laboratory, respectively.
- For $PM_{2.5}$, the Laser Egg 2+ sensors showed moderate to strong correlations with the FEM BAM, FEM GRIMM and FEM T640 from the field ($PM_{2.5}$ 0.59 < R^2 < 0.88) and showed very weak correlations with GRIMM, FEM BAM and T640 for PM_{10} (R^2 < 0.31). The Laser Egg 2+ sensors showed very strong correlations with the FEM GRIMM in the laboratory studies (R^2 > 0.99 for $PM_{2.5}$).
- The same three Laser Egg 2+ units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing)

Field Evaluation Highlights

- Deployment period 02/19/2019 - 04/09/2019: the three Kaiterra Laser Egg 2+ sensors showed moderate to strong correlations with $PM_{2.5}$ mass concentration as monitored by FEM BAM, FEM GRIMM and FEM T640. PM_{10} mass conc. showed very weak correlations with the corresponding GRIMM, FEM BAM and T640 data
- The units showed low intra-model variability and data recovery for $PM_{2.5}$ and PM_{10} was ~76% and 77%, respectively.

1-hr mean, all ref. instr.

$PM_{2.5}$: 0.59 < R^2 < 0.88

PM_{10}: 0.12 < R^2 < 0.31

$PM_{2.5}$ (1-hr mean, µg/m³)

y = 0.4972x + 3.0244
R^2 = 0.8757

Kaiterra Laser Egg 2+ vs FEM GRIMM

Coefficient of Determination (R^2) quantifies how the three sensors followed the $PM_{2.5}$ concentration change by the reference instruments.

An R^2 approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.
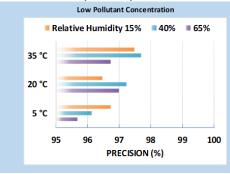
Laboratory Evaluation Highlights

Accuracy (PM$_{2.5}$)

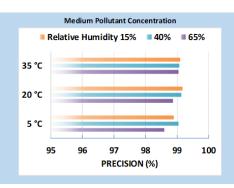| Steady state #	Sensor Mean (µg/m³)	FEM GRIMM (µg/m³)	Accuracy (%)
1	9.4	6.5	54.5
2	17.4	11.4	47.2
3	47.0	34.8	64.9
4	163.3	108.8	49.9
5	287.1	193.5	51.6
6	451.0	302.7	51.0

Accuracy was evaluated by a concentration ramping experiment at 20 °C and 40%. The sensor's readings at each ramping steady state are compared to the reference instrument.
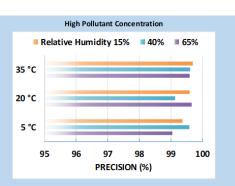
A negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.
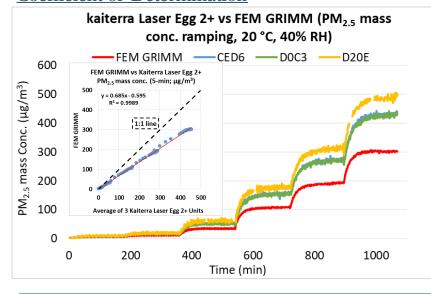
Precision (PM$_{2.5}$)

100% represents high precision.

Sensor's ability to generate precise measurements of PM$_{2.5}$ concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%) cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

Coefficient of Determination

The Kaiterra Laser Egg 2+sensors showed very strong correlations with the corresponding FEM PM$_{2.5}$ data (R^2 > 0.99) at 20 °C and 40% RH.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the Kaiterra Laser Egg 2+ sensor; at the set-points of RH change, the sensors showed some small spiked conc. Changes.

Observed Interferents
N/A